

RECEIVED

JUN 26 1978

PRINTING SERVICES BRANCH  
PUBLICATIONS CENTRE

**AMBIENT AIR QUALITY  
IN THE  
SARNIA AREA  
1972 to 1976**



Ontario

Ministry  
of the  
Environment

ONTARIO LEGISLATIVE LIBRARY  
TORONTO

JAN - 1990

RECEIVED

### Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at [copyright@ontario.ca](mailto:copyright@ontario.ca)

E R R A T A

- 1) Page 18, penultimate line should read "... air are produced primarily through a ...."
- 2) Page 22, second line should read "... where it is released in ...."

CA20N  
EVR.75  
A52  
c.1

AMBIENT AIR QUALITY  
IN THE  
SARNIA AREA  
1972 TO 1976

Technical Support Section  
Southwestern Region  
ONTARIO MINISTRY OF THE ENVIRONMENT

September 1977

## TABLE OF CONTENTS

	<u>Page No.</u>
SUMMARY	1
INTRODUCTION	3
DESCRIPTION OF MONITORING NETWORK	4
METEOROLOGICAL DATA	4
PARTICULATES	5
SULPHUR OXIDES	9
HYDROGEN SULPHIDE AND MERCAPTANS	14
CARBON MONOXIDE	15
NITROGEN OXIDES	16
HYDROCARBONS	17
OXIDANTS	18
FLUORIDATION RATE	22
 DISCUSSION	 24
 APPENDIX I        -    DESCRIPTION OF MONITORING NETWORK	
Figure I:        Location of Monitoring Stations	
Table I:         Location of Monitoring Stations and Pollutants Monitored	
Table II:        Desirable Ambient Air Quality Criteria Established for Ontario	
 APPENDIX II       -    METEOROLOGICAL DATA	
Table III:       Average Frequency of Wind Direction at the 62-Metre Level of Station 14016	

APPENDIX III - PARTICULATES

Table IV:	Concentrations of Dustfall in Downtown Sarnia
Table V:	Trend in Levels of Suspended Particulates 1972 to 1976

APPENDIX IV - CARBON MONOXIDE, TOTAL HYDROCARBONS,  
HYDROGEN SULPHIDE AND MERCAPTANS, OXIDES  
OF NITROGEN, TOTAL OXIDANTS, OZONE AND  
SOILING INDEX DATA OBTAINED IN DOWNTOWN  
SARNIA

Table VI:	Summary of Data for Some Pollutants Measured in Downtown Sarnia
-----------	--------------------------------------------------------------------

APPENDIX V - SULPHUR OXIDES

Table VII:	Trend in Levels of Sulphur Dioxide - 1972 to 1976
Table VIII:	Trend in Levels of Sulphation Rate - 1972 to 1976
Table IX:	Summary of Sulphate Content in Suspended Particulates During 1976

APPENDIX VI - FLUORIDATION RATE

Table X:	Fluoridation Rates - 1972 to 1976
----------	--------------------------------------

## SUMMARY

During 1976 most pollutants measured in the ambient air of the Sarnia area were at or approaching the desirable criteria. However, in southern Ontario and much of the United States there has not been a significant trend of decreasing frequency of ozone concentrations above the criterion for desirable ambient air since 1974. The elevated levels of ozone are due to local emissions of pollutants as well as emissions from distant areas and subsequent transport of the pollutants that increases local concentrations. The long-range transport of pollutants that react to form ozone dictates that control strategies being considered for ozone in Ontario must be compatible with those strategies being developed for those areas of the United States that might contribute to ozone pollution in this province. The ambient air criterion for ozone is based on the protection of vegetation and human health. Phytotoxicology studies conducted by the Ministry of the Environment have detected vegetation damage attributable to ozone to varying degrees throughout southwestern Ontario. Although levels of ozone have been reached that may create adverse health effects, there have been no documented cases of detrimental health effects attributed to ozone in Ontario.

During 1976 there were an unacceptable number of occasions when concentrations of sulphur dioxide exceeded the desirable ambient air criteria for 1-hour and 24-hours in downtown Sarnia and south of Courtright in the vicinity of the power generating plants of Detroit Edison and Ontario Hydro. For 1977, Detroit Edison has scheduled reductions in

sulphur dioxide emissions and improvement in the dispersion of emissions that should reduce the frequency of excursions above the criteria for sulphur dioxide to satisfactory levels south of Courtright. The Ministry of the Environment is developing a more stringent control strategy for emissions of sulphur dioxide in order to reduce the frequency of excursions above the desirable ambient air criteria in Sarnia to satisfactory levels.

During 1976 a limited amount of monitoring in the vicinity of the fertilizer plant of Canadian Industries Limited detected levels of fluorides above a desirable ambient air criterion established for the protection of vegetation. Phytotoxicology investigations by this Ministry have revealed above background levels of fluorides in vegetation but fluoride damage to vegetation has not been noted off Company property.



## INTRODUCTION

The ambient air monitoring network operated in the Sarnia area by the Ontario Ministry of the Environment is designed to measure a number of pollutants which may be directly or indirectly harmful to health, vegetation or property and to provide an indication of the point and area sources of these pollutants. Most of the monitoring equipment is located in areas suspected of exhibiting poorer air quality such as those close to heavily industrialized and commercial areas. When the air quality is acceptable in these areas then the residential and rural areas are normally found to have satisfactory air quality.

Some pollutants such as sulphur dioxide and particulates are measured at several locations in the Sarnia area while others such as carbon monoxide and oxides of nitrogen are measured only at the main monitoring station located in downtown Sarnia. In addition to the monitoring conducted by the Ministry of the Environment, an extensive monitoring network is maintained by the Ontario Research Foundation under contract from the Lambton Industrial Society. Also, some private industries and Ontario Hydro conduct ambient air monitoring in the Sarnia area. This report discusses only data collected by the Ministry of the Environment but the data provided by others greatly assist in the interpretation of the status of air quality and the quality assurance of data.

As well as presenting the 1976 ambient air quality data this report presents a summary of the data collected by this Ministry since 1972. Data collected since the beginning of 1972 are sufficiently comprehensive to permit a basis for annual comparisons and overall trends.

DESCRIPTION OF  
MONITORING NETWORK

A mixture of continuous and intermittent ambient air monitors dispersed throughout the Sarnia area constitutes the Ministry's monitoring network.

There is a tendency for industry and power generating stations to locate close to the St. Clair River south of Sarnia. Southerly winds blow pollutants from industries and generating stations into Sarnia and high pollution levels may be measured when plumes from several emission sources overlap. This additive impact along with the concentration of population, magnitude of vehicle emissions and commercial sources of pollution have resulted in air monitoring being conducted relatively intensively in the Sarnia area.

The location of the monitoring stations are illustrated in Figure I, Appendix I and the specific locations including elevations are listed in Table I, Appendix I. The pollutants being monitored at individual stations are also included in Table I. The Ministry of the Environment's desirable ambient air quality criteria for pollutants measured in the Sarnia area and the prime basis for these criteria are contained in Table II, Appendix I.

METEOROLOGICAL DATA

Meteorological data are collected at station 14016 located immediately south of Courtright. Wind speed and wind direction are measured continuously at 10 metres, 62

metres, and 92 metres above ground level. In addition, ambient air temperature is recorded for the 10-metre level and the difference in ambient air temperature between the 10-metre and 62-metre levels and the 10-metre and 92 meter levels are recorded.

Approximately every ten minutes the meteorological data are telemetered to a computer located in a Ministry office in Toronto. If extremely adverse pollution levels exist, current meteorological data are available to forecast the duration of adverse meteorological conditions. The meteorological data are also used in detailed studies of ambient air pollution concentrations and the dispersion of pollutants from specific emission sources.

Table III, Appendix II lists the average annual percentage of the time the wind has been blowing from various directions as recorded at the 62-metre level during the years 1972 through 1976. The data illustrate appreciable variation in annual frequency of wind direction from the east, south, and west.

#### PARTICULATES

Particulates are emitted into the atmosphere by many of man's activities as well as by nature. Some direct emissions by man are a result of such activities as combustion of fuels, handling and transportation of particulates, and construction. Indirect emissions may result when

particulates are re-entrained into the atmosphere by vehicle traffic. Wind erosion of exposed land, dirt piles and particulates which have settled on smooth surfaces such as paved roads and buildings accounts for a very significant portion of the particulates in the ambient air.

Particulates in the ambient air are measured directly as dustfall and suspended particulates and indirectly as soiling index. The dustfall measurement is determined by weighing the amount of dust collected in an open jar of specific diameter during 30 days of exposure. Suspended particulates are calculated by measuring the amount of particulate drawn through a filter paper with a measured amount of air over a 24-hour period. Soiling index measures the difference between the amount of light transmitted through filter paper before and after a computed amount of air has been drawn through the paper. The soiling index is expressed in coefficient of haze (COH) units per 1000 feet of air. Since transmittance of light will depend on the size, shape and quantity of the particulates collected on the filter paper, the soiling index can only be empirically related to the mass of particulates in the air. However, the soiling index can be computed instantaneously in the field to provide an immediate indication of the particulate conditions. Measurements for dustfall and suspended particulates require laboratory analyses which result in delays in the availability of data.

#### Dustfall

The desirable ambient air criteria for dustfall are 20 tons of dustfall per square mile per 30 days and an annual average of 13 tons of dustfall per square mile per 30

days. These dustfall criteria are based on historical data and criteria established by other enforcement agencies. Dustfall measurements are made at two locations in downtown Sarnia, stations 14049 and 14051. The monthly dustfall values obtained since 1972 are normally below the desirable criterion and the infrequent excursions are only marginally greater than the criterion. The data appear in Table IV, Appendix III. Similarly the annual criterion has normally been met or just marginally exceeded since 1972.

#### Suspended Particulate

Desirable ambient air criteria for suspended particulates are 120 micrograms per cubic metre of air ( $\text{ug}/\text{m}^3$ ) during the 24-hour period of midnight to midnight and an annual geometric mean of  $60 \text{ ug}/\text{m}^3$ . The 24-hour criterion was established relative to impairment of visibility and the annual criterion on the basis of damage to property.

During 1976 samples for suspended particulates were collected from seven monitoring stations in the Sarnia area. The annual desirable ambient air criterion was exceeded at only one station which is located in downtown Sarnia. The desirable ambient air criterion for 24-hours was exceeded at six of the seven stations. The station at which this criterion was not exceeded is located in Corunna. When meteorological conditions are adverse excursions above the criterion for 24-hours are common in otherwise unpolluted areas. However, at station 14049 in downtown Sarnia,

20 per cent of the concentrations of suspended particulate in 1976 were above  $120 \text{ ug/m}^3$ , well above the expected excursion frequency. During 1975 only 12 per cent of the values obtained at station 14049 were above  $120 \text{ ug/m}^3$ . This increase in the frequency of elevated levels of suspended particulate in 1976 is attributed to a greater occurrence of sustained southerly and southwesterly winds carrying particulates from area and point sources located south and southwest of Sarnia. Samples for determination of suspended particulates are obtained on an every-day schedule at station 14049 and every sixth day at other Sarnia area stations. During 1976, the samplers on the schedule of every sixth day did not reflect the frequency of elevated levels of suspended particulates that was obtained at station 14049 and cannot be considered to provide results that were altogether representative for the complete year.

Sampling for suspended particulates at station 14055 in the industrial area of south Sarnia was interrupted in 1976 due to power losses caused by a major construction project. The construction project created elevated levels of suspended particulates and sampling would not have been representative of ambient air quality in the general industrial area.

Since 1972 suspended particulates have exhibited a downward trend in the annual geometric mean concentration and the percentage of daily concentrations above the 24-hour criterion. The decreasing trend is illustrated in the data presented in Table V, Appendix III.

### Soiling Index

Readings for soiling index are determined only at the main monitoring station (14049) in downtown Sarnia. The desirable ambient air criteria are 0.5 COH per hour averaged for 1 year and 1.0 COH per hour average for 1 day. These criteria are based on adverse health effects created by suspended particulates in association with elevated levels of sulphur dioxide. The annual average was 0.4 COH in 1972 and has been 0.3 COH in subsequent years so that the annual criterion has been met each year. The ambient air criterion for 24-hours was exceeded only once in 1974 and twice in 1976. The excursions in 1976 were a result of emissions from an improperly adjusted boiler, located in the immediate vicinity of the monitoring station. Black soot was collected by the air intake of the soiling index monitor. The direct reading of the soiling index resulted in quick recognition of the emission source and corrective action was subsequently taken. The levels of soiling index in Sarnia are representative of desirable ambient air quality. Data for soiling index appear in Table VI, Appendix IV.

### SULPHUR OXIDES

The main man-made source of sulphur oxides is the combustion of sulphur-containing fossil and petroleum fuels. In the Sarnia area combustion of large amounts of these

fuels occurs at the power generating plants located in both Michigan and Ontario and at the petrochemical industries located south of downtown Sarnia. During combustion the sulphur in the fuel is oxidized to sulphur dioxide and emitted into the atmosphere in the flue gas. In the atmosphere some sulphur dioxide is oxidized to sulphate while some is absorbed by the ground and vegetation.

Sulphur oxides are measured in the Sarnia area by this Ministry utilizing continuous sulphur dioxide gas analyzers, laboratory analyses of particulate matter for sulphate content, and the sulphation rate technique. Sulphation rate is determined by exposing a plate or filter coated with lead peroxide for a period of 30 days. During the 30-day exposure period oxidizable sulphur compounds in the ambient air react with the lead peroxide to form lead sulphate. The sulphate content on the plate or filter is subsequently measured at the Ministry's laboratory in Toronto.

#### Sulphur Oxides

For sulphur dioxide the criteria for desirable ambient air are 0.25 parts per million (ppm) as the average concentration for one hour, 0.10 ppm as the average concentration for the 24-hour period of midnight to midnight, and 0.02 ppm as the average concentration for 1 year. The criteria established for the 1-hour and annual periods are based on damage to vegetation while the criterion established for 24-hours is based on adverse health effects.



There are three continuous monitors for sulphur dioxide operated by the Ministry of the Environment in the Sarnia area. One monitor is strategically located at station 14049 in downtown Sarnia while the other two monitors are located south of Courtright in the environs of Ontario Hydro's Lambton Generating Plant and Detroit Edison's St. Clair Generating Plant. Since the main sources of sulphur dioxide in the area are situated to the south of downtown Sarnia the monitor at station 14049 detects the combined contributions of several sources when winds are blowing from southerly and southwesterly directions.

With the exception of 1974 when the annual average concentration for sulphur dioxide was 0.03 ppm, the annual criterion of 0.02 ppm has been met at station 14049 since 1972. However, both the criterion for 24-hours and the criterion for 1-hour have been exceeded each year since 1972. The hourly criterion was exceeded more frequently during the period from 1972 through 1974 than in 1975 and 1976. Also, at station 14049 the maximum concentrations recorded for individual years exceeded the hourly criterion by a greater magnitude during 1972 to 1974 than in 1975 or 1976. Contrastingly, the frequency and magnitude of excursions above the 24-hour criterion have not demonstrated the improving air quality trend described for the hourly criterion. The air quality data reveal that there has been essentially no improvement since 1973 with respect to the frequency and magnitude by which the 24-hour criterion is exceeded at station 14049. A new strategy for controlling sulphur dioxide is currently being developed by this Ministry to lower the sulphur dioxide levels in the Sarnia area to acceptable (if not desirable) levels. Data summarizing the trend in concentrations of sulphur dioxide appear in Table VII, Appendix V.

Station 14016 houses one of the monitors for sulphur dioxide in the vicinity of the two generating plants south of Courtright. This station is located immediately northwest of Ontario Hydro's Lambton Generating Plant and sufficient data to permit evaluation of sulphur dioxide levels have been recorded at this station since the beginning of 1973. The data reveal that both the annual and the 24-hour criteria have been met continuously since 1973. The hourly criterion has been exceeded occasionally each year and the maximum value has been much greater than the criterion. The frequency of excursions above the hourly criterion has decreased since 1974.

The remaining monitor for sulphur dioxide is housed at station 14004 which is located east of the Detroit Edison's St. Clair Generating Plant. This monitoring site was selected to evaluate the effect of downdrafting of the plumes from the St. Clair Generating Plant on air quality. The sulphur dioxide data collected since mid-1975 reveal that the annual criterion is being met but the hourly and 24-hour criteria are exceeded excessively in both frequency and magnitude.

A pollution control program at the St. Clair Generating Plant should reduce the amount of sulphur dioxide emitted and also improve the dispersion of the plumes. It is anticipated that this control program will result in acceptable levels of sulphur dioxide being recorded at stations 14004 and 14016.

### Sulphation Rate

The desirable ambient air criterion for sulphation rate is 0.70 milligrams (mg) of sulphur trioxide ( $\text{SO}_3$ ) per  $100 \text{ cm}^2$  of filter paper per day, determined by exposure of the lead peroxide filter for 30 days. This monthly criterion was established with the intention of it being compatible with the annual average concentration of sulphur dioxide, for which an ambient air criterion exists based on vegetation damage.

Sulphation rates are monitored at 11 sites in the Sarnia area to provide information on the relative amounts of sulphur oxides in specific areas. A summary of data from 1972 through 1976 appears in Table VIII, Appendix V. Since 1972 there has been a decreasing trend in sulphation rate. This is demonstrated by lower annual levels and a reduction in the percentage of values greater than the monthly criterion. Despite the decreasing trend in sulphation rate, stations 14049 and 14051 located in downtown Sarnia and station 14055 located in the industrialized section of south Sarnia have repeatedly had annual average values above the criterion established for the exposure period of 30 days. At these stations the percentage of values above the monthly criterion has also been excessive.

### Sulphate Content In Suspended Particulates

The sulphate content in suspended particulates has been determined intermittently in the Sarnia area since

1969. In 1976 a more intensive sulphate monitoring program was initiated so that essentially all suspended particulate filters collected at 4 air monitoring stations were analyzed for sulphates. One station (14016) is located south of Courtright, two stations (14001 and 14051) are located in central Sarnia and the fourth station (14054) is in north Sarnia. During 1976 the percentage of sulphate contained in the suspended particulates was (on average) very similar at the various stations. The average percentages ranged from 13 to 16. The average concentration ranged from 8.4 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) to  $9.6 \mu\text{g}/\text{m}^3$ . The percentages of sulphate content in suspended particulates are slightly greater than the percentages reported for London and Windsor where the averages were 11 per cent during 1976. Table IX, Appendix V, contains a summary of the data obtained in 1976 on the sulphate content of suspended particulates. The quantity of data collected prior to 1976 is insufficient to include in an analysis of trend.

#### HYDROGEN SULPHIDE AND MERCAPTANS

Hydrogen sulphide and mercaptans are measured collectively at station 14049 in downtown Sarnia. Mercaptans, a group of organic compounds that contain sulphur and hydrogen, possess similar characteristics to hydrogen sulphide. Hydrogen sulphide is commonly referred to as rotten egg gas and many of the mercaptan compounds also exhibit offensive

odours at extremely low concentrations. Both hydrogen sulphide and mercaptans originate in nature from the anaerobic decomposition of organic matter containing sulphur. In Sarnia, the processing of petroleum feedstocks containing sulphur can result in the release of hydrogen sulphide and mercaptans to the atmosphere.

For hydrogen sulphide the criterion for desirable ambient air is 0.02 ppm as an average for 1 hour. This criterion is based on the offensive odours exhibited by this gas. Since mercaptans are also very malodorous and no criterion has been established for mercaptans, the combined concentrations of hydrogen sulphide and mercaptans are compared to the criterion for hydrogen sulphide.

Prior to 1974 there were insufficient data available to comment on trends for hydrogen sulphide and mercaptan. Data obtained since April, 1974 reveal a sharp downward trend in the levels of hydrogen sulphide and mercaptans. The decrease in the frequency of excursions above the criterion for 1 hour and the decrease in the annual average concentration may undoubtedly be attributed to a better operation of industrial processes and associated pollution control equipment. A summary of the data for the combined concentrations of hydrogen sulphide and mercaptans appears in Table VI, Appendix IV.

#### CARBON MONOXIDE

Carbon monoxide is emitted by combustion operations which oxidize carbon to carbon monoxide. Exhausts

from motor vehicles are the largest man-made source of carbon monoxide. Industrial processes also emit significant amounts of this gas.

The criteria for carbon monoxide are established on the basis of the protection of human health. The criterion for 1 hour is 30 ppm and the criterion for any consecutive 8-hour period is 13 ppm.

Carbon monoxide is monitored at station 14049, located in downtown Sarnia. This station is exposed to the exhaust from the heavy downtown traffic and concentrations at this site should be representative of the highest concentrations in the area. The criteria have not been exceeded since monitoring commenced at this site in 1969 (monitoring was interrupted for one year). The maximum one-hour concentration reported during 1976 was 6 ppm, well below the 30 ppm criterion. The annual average concentration of carbon monoxide has been reduced appreciably since 1972. A summary of the data is included in Table VI, Appendix IV.

#### NITROGEN OXIDES

The main man-made source of nitrogen oxides is the combustion of fuel. As for carbon monoxide, the motor vehicle is the prime source and industrial processes and power generating plants are significant contributors.

Nitrogen oxides are measured in the ambient air continuously at station 14049 in downtown Sarnia. The monitoring instrument determines the amount of nitric oxide gas and the amount of nitrogen oxide gases and the difference between the values for these gases is reported as nitrogen dioxide gas.

No desirable ambient air criteria have been established for nitric oxide or nitrogen oxides. Criteria established for nitrogen dioxide are based on odour threshold and the protection of human health. Neither the desirable ambient air criterion of 0.20 ppm for 1 hour nor the 24-hour criterion of 0.10 ppm has been exceeded since monitoring began in 1972.

The annual average concentration of nitrogen dioxide has remained relatively consistent since 1972. There are insufficient data to permit comparisons prior to 1975 or to determine a trend in the concentrations of nitrogen oxides or nitric oxide. Data for oxides of nitrogen appear in Table VI, Appendix IV.

Nitrogen oxides are very important in the production of photochemical oxidants. Photochemical oxidants and the significance of nitrogen oxides are discussed later in this report in the section on oxidants.

#### HYDROCARBONS

Natural phenomena produce many hydrocarbons. The most abundant hydrocarbon present in the ambient air is

methane which is formed in large quantities by man-made and natural processes. Significant man-made sources of hydrocarbons are the incomplete combustion of organic and fossil fuels and losses due to evaporation during the storage and transportation of hydrocarbons.

Owing to the wide range of effects associated with different hydrocarbons at various concentrations, no desirable ambient air criteria have been established for total hydrocarbons. Instead, control is achieved by setting desirable ambient air criteria for specific hydrocarbons and/or establishing standards for specific hydrocarbons which control the impact of an emission source.

Total hydrocarbons are monitored in downtown Sarnia at station 14049. The annual average concentration of total hydrocarbons has been very consistent since 1972. Data for total hydrocarbons appear in Table VI, Appendix IV.

Non-methane hydrocarbons may photochemically react with nitrogen oxides to produce oxidants. Therefore, the control of oxidants may involve the control of hydrocarbons and nitrogen oxides. Photochemical oxidants and the role of hydrocarbons are discussed more fully in the section on oxidants.

#### OXIDANTS

Oxidants in the ambient air are primarily a series of photochemical reactions and inter-reactions



involving nitrogen oxides and hydrocarbons. Ozone generally accounts for over 90 per cent of the oxidants in the ambient air. Peroxyacetyl nitrate (PAN) is an important photochemical oxidant which at very low concentrations may cause vegetation damage or adversely affect health.

The desirable ambient air criterion for total oxidants is 0.100 ppm averaged for 1 hour and the criterion for ozone is 0.080 ppm averaged for 1 hour. These criteria were established on the basis of detrimental effects to vegetation and human health.

All the photochemical reactions and inter-reactions that are involved in the formation of photochemical oxidants have not been confirmed. One of the basic reactions which can occur when there is sufficient energy available from sunlight is the reduction of nitrogen dioxide to nitric oxide and an oxygen atom. The resulting oxygen atom is able to react with oxygen gas to produce ozone. Nitric oxide may react with either ozone or hydrocarbons to produce nitrogen dioxide which, as previously indicated, can react photochemically to produce more ozone. Consequently, hydrocarbons are extremely important to the ambient concentrations of ozone because their reactions with nitric oxide reduce the amount of nitric oxide available to react with ozone and these same reactions produce nitrogen dioxide that may subsequently react to form ozone.

Photochemical reactants are produced by man and nature. Nitrogen oxides and hydrocarbons emitted to the atmosphere from fuel combustion sources such as vehicular

traffic and fossil-fueled power generating plants constitute the bulk of the man-made photochemical reactants. Soil reactions are one source of nitrogen oxides produced by nature. The release of terpenes from coniferous trees and the decomposition of organic matter are natural sources of hydrocarbons. Studies have shown that photochemical reactants produced by nature can create oxidant levels in the range of the desirable ambient air criterion. Significant concentrations of ozone are occasionally caused by convection currents bringing ozone from the ozone layer surrounding the earth in the outer stratosphere to the surface of the earth. Furthermore, ozone is generated by lightning in amounts significant enough to be detected by air monitoring equipment.

Oxidants and their precursor chemicals have been proven to travel great distances. The long-range transport of oxidants and their precursor chemicals necessitates the use of compatible control strategies by various control agencies. Oxidant concentrations in the Sarnia area are not only a result of nitrogen oxides and hydrocarbons emitted in the Sarnia area but also emissions of these precursor chemicals in other areas of Ontario and the United States.

The Ministry continuously monitored total oxidants in downtown Sarnia at station 14049 during 1972 and 1973. In 1974, total oxidant monitoring was replaced with the more accurate and specific ozone monitoring. The total oxidant 1-hour criterion of .100 ppm was exceeded 0.9 and 0.7 percent of the monitoring time in 1972 and 1973 respectively. The 1-hour ozone criterion of 0.080 ppm has been exceeded 1.1,

1.9, and 0.7 percent of the monitoring time respectively during the years 1974, 1975 and 1976. Also, the annual average concentration of ozone was greater in 1975 than in either 1974 or 1976. A summary of the total oxidant and ozone data appears in Table VI, Appendix IV.

Excursions above the desirable ambient air criterion for ozone has been paralleled throughout southern Ontario and initial reports indicate that much of North America has experienced a similar frequency of higher levels of ozone. The widespread excursion of an ambient air criterion based on detrimental effects to human health and vegetation has created a great deal of concern within the Ministry of the Environment. Control strategies are being considered that will be compatible with those being considered and implemented in nearby areas of the United States. This is very essential because of the long range transport of ozone and its precursors as previously discussed.

The adverse health effects associated with oxidants (including ozone) are nausea, respiratory difficulties, eye irritation, and less efficient physical performance. It should be noted that in Ontario there has been no documented case of adverse health effects due to photochemical oxidants.

Annual phytotoxicology surveys are conducted in southern Ontario by this Ministry to determine the extent of vegetation damage due to ozone. The 1976 phytotoxicology survey revealed damage to crops of a similar magnitude as the 1975 survey. It must be recognized that many factors, such as type and age of vegetation, soil conditions, and meteorological conditions govern the degree of vegetation damage caused by ozone.

### FLUORIDATION RATE

In the Sarnia area fluorides are emitted into the atmosphere by a fertilizer plant where it is reduced in the processing of phosphate-bearing rock, by petroleum refineries where it is used as a catalyst in alkylation operations, and by the combustion of coal that contains trace amounts of fluorides.

Fluoridation rate is a measurement technique designed to indicate the quantity of fluoride gas in the air. This technique features the exposure of limed filter paper for a thirty-day period and subsequent laboratory analysis of 100 square centimeters ( $\text{cm}^2$ ) of filter to determine the fluoride content.

The desirable ambient air criteria for fluoridation rate are based on vegetation damage. Consequently, there is a criterion established for the growing season from April 15 to October 15 of 40 micrograms ( $\mu\text{g}$ ) of fluoride per 100  $\text{cm}^2$  of limed filter paper per 30 days, as well as a criterion of 80  $\mu\text{g F}/100 \text{ cm}^2/30$  days for the period of October 16 to April 14. Since the months of April and October are included in both criteria, excursions above the criteria during these months are determined by comparing the fluoridation rate to the average of the two criteria (60  $\mu\text{gF}/100 \text{ cm}^2/30$  days).

Fluoridation rates have been monitored since 1970 by the Ministry at station 14049 in downtown Sarnia and since mid-1976 at station 14004 located south of the fertilizer plant of Canadian Industries Limited. In addition, an extensive network for monitoring fluoridation rates has been operated by Canadian Industries Limited since the late 1960's. Annual phytotoxicology surveys are conducted by the Ministry of the Environment to determine if vegetation damage is being caused by fluorides.

Data for station 14049 in downtown Sarnia reveal a downward trend in the annual average fluoridation rate and the frequency with which the fluoridation rate criteria are exceeded. In 1976, there was only one excursion and that was a very marginal excursion of the criterion during the growing season. Table X, Appendix VI contains data on fluoridation rates obtained since 1972. Phytotoxicology surveys have not detected any fluoride damage to vegetation in the area of refineries located in Sarnia.

The limited amount of data available from monitoring at station 14004 during 1976 reveals elevated levels above the criterion for the growing season. Phytotoxicology investigations have detected elevated fluoride levels in vegetation on the property of Canadian Industries Limited as well as some vegetation damage. Outside the Company's property, fluoride levels above background have been detected in vegetation but vegetation damage has been virtually non-existent.

### DISCUSSION

Since 1972 many air pollutants being monitored on a routine basis in Sarnia have exhibited a decreasing trend in the frequency that desirable ambient air quality criteria are exceeded and in the concentrations determined for annual averages. The decreasing trends are most evident for suspended particulates, sulphation rates, hydrogen sulphide and fluoridation rates monitored in downtown Sarnia.

The most notable exceptions to the decreasing trends in the frequency of excursions above the criteria for desirable ambient air and annual average concentrations are ozone and sulphur dioxide. The frequency of excursions above the criterion for ozone has fluctuated in Sarnia as well as much of North America. Excursions above the criterion (based on effects to health and vegetation) and the repeated damage to vegetation in southern Ontario due to ozone and other oxidants create a need for a new control strategy for oxidants. Control strategies being considered must be compatible with strategies being developed by other control agencies in order to be effective.

At station 14004 the frequency of excursions above the 1-hour and the 24-hour criteria for sulphur dioxide should soon be curtailed and improvements noted because of better control facilities and better dispersion associated with emissions from the St. Clair Generating Plant of

Detroit Edison. In downtown Sarnia, improvement in the frequency of and magnitude of excursions above the 24-hour criterion for sulphur dioxide should materialize after a new control strategy being developed for emissions of sulphur dioxide in the Sarnia area is implemented.

This report does not include a section on odours in the Sarnia area. Odours are subject to individual sensitivity and are extremely difficult to relate to specific chemicals. The reduction in levels of hydrogen sulphide and mercaptans has reduced offensive odours created by those chemicals. An obvious overall improvement in recent years can be related to fewer process upsets and a general tightening of emissions to the atmosphere.

Also absent from this report is a section on the more exotic chemicals that are not monitored on a routine basis. The monitoring of total hydrocarbons does not provide the proportion of the specific hydrocarbons present in the ambient air. However, during 1976 this Ministry did monitor for vinyl chloride and ethylene in Sarnia. During 1977 a more extensive survey of specific hydrocarbons has been conducted. It will be imperative to devote more attention to the identification and quantification of specific hydrocarbon compounds as sampling and analytical capabilities are expanded, based on improved instrumentation and analytical techniques.

APPENDIX I

DESCRIPTION OF  
MONITORING NETWORK



FIGURE 1 - LOCATION OF MONITORING STATIONS

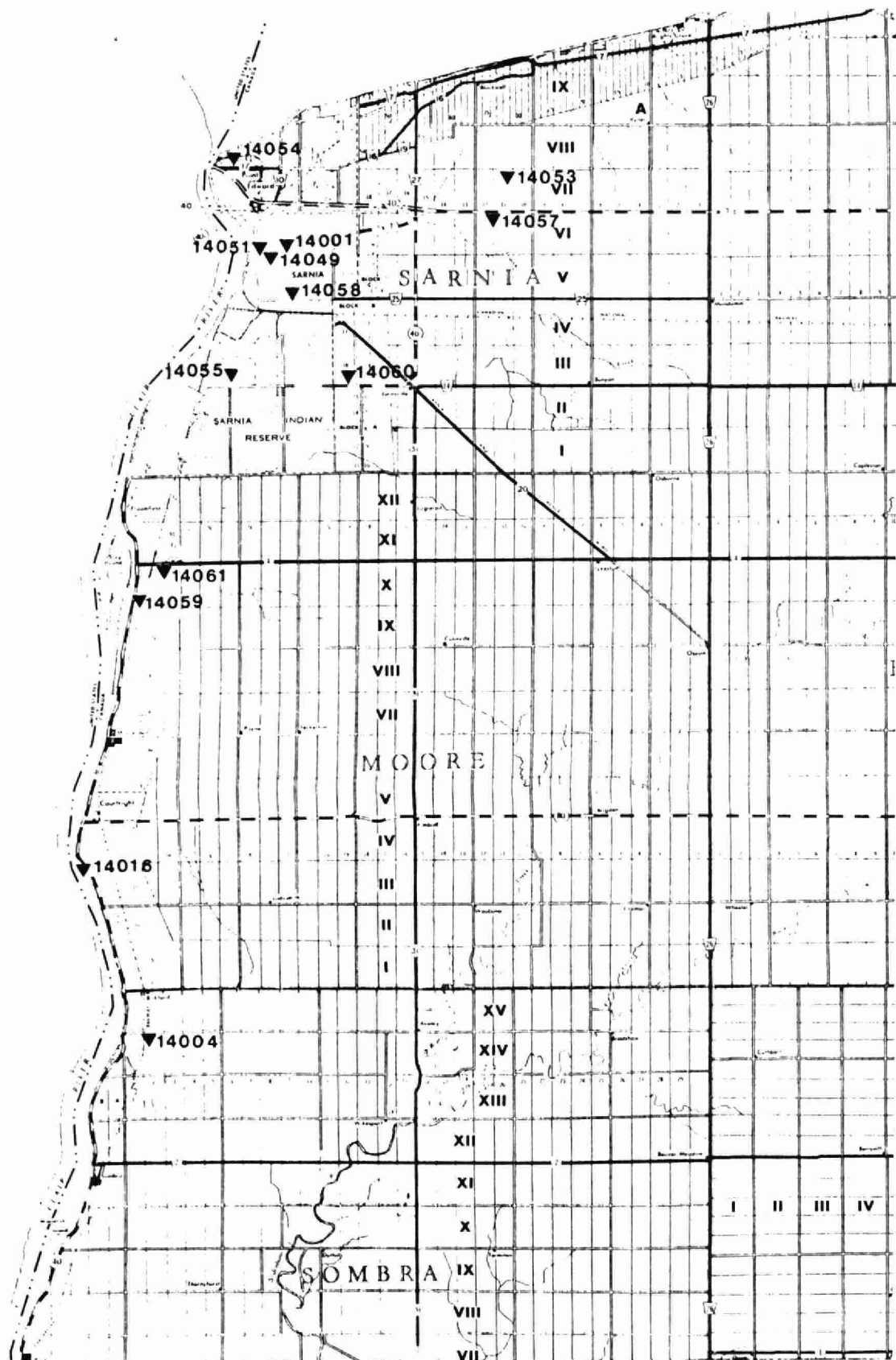


TABLE 1 - LOCATION OF MONITORING STATIONS  
AND POLLUTANTS MONITORED

STATION NO.	LOCATION	PARAMETERS MEASURED	HEIGHT OF MEASUREMENT	PURPOSE OF STATION & COMMENTS
14001	Sarnia General Hospital	Suspended Particulates	16 m.	Historical station which has been in operation since 1962. Does not reflect ground level concentrations but does indicate more direct effects of particulates from high stacks.
14004	5 1/2 miles south of Courtright	Continuous SO <sub>2</sub> , Fluoridation Rate	4 m.	Monitors SO <sub>2</sub> from power generating stations and fluorides from fertilizer industry.
14016	1 1/4 miles south of Courtright	Suspended Particulates, Continuous SO <sub>2</sub> , Sulphation Rate, WS, WD, Temp., WS, WD, Δ Temp., Telemetering Equipment	1 m. 4 m. 4 m. 10 m. 60 m.	Monitors suspended particulates and sulphur dioxides in relation to power generating plants. Provides meteorological data required for stability forecasts and air quality interpretations.
14049	Victoria St., Downtown Sarnia	Continuous SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , H <sub>2</sub> S & Mercaptans, Total Hydrocarbons, 2-HR. COH, 1-HR. COH, Suspended Particulates, Dustfall, Fluoridation Rate, Sulphation Rate	4 m.	Monitors main air pollutants in a heavily populated area where the pollutants from traffic, commercial establishments, and the heavily industrialized complex south of the monitoring station should be high relative to residential areas.

TABLE I - continued

STATION NO.	LOCATION	PARAMETERS MEASURED	HEIGHT OF MEASUREMENT	PURPOSE OF STATION & COMMENTS
14051	Front & Lochiel St., Downtown Sarnia	Sulphation Rate, Suspended Particulates, Dustfall	3 m.	Monitors pollutants in commercial area which is also affected by heavily industrialized area to south. Since this is the location of a monitoring station operated by the Lambton Industrial Society, cross checking of monitoring techniques is possible.
14053	Sarnia Airport	Sulphation Rate	1 m.	Provides relative amounts of sulphur oxide compared to other areas of Lambton County.
14054	Sarnia Yacht Club	Sulphation Rate Suspended Particulates	5 m.	Monitors suspended particulates and relative amounts of sulphur oxides in the north Sarnia-Point Edward area.
14055	Churchill Road and Tashmoo St.	Sulphation Rate	4 m.	Monitors relative amounts of sulphur oxides in the Sarnia industrial complex.
14057	Briarwood Recreation Centre	Sulphation Rate, Suspended Particulates	10 m.	Monitors suspended particulates and relative amounts of sulphur oxides in Sarnia Township, northeast of the main industrial area.
14058	Tecumseh Park, Sarnia	Sulphation Rate	4 m.	Monitors relative amount of sulphur oxides in south residential Sarnia, close to the industrial area.

TABLE I - continued

STATION NO.	LOCATION	PARAMETERS MEASURED	HEIGHT OF MEASUREMENT	PURPOSE OF STATION & COMMENTS
14059	Riverbend, Corunna	Sulphation Rate, Suspended Particulates	4 m.	Monitors suspended particulates and relative amounts of sulphur oxides in the residential area of Corunna which is surrounded by industry and generating stations.
14060	MacGregor St. & Hwy. 40, Sarnia	Sulphation Rate	4 m.	Monitors relative amount of sulphur oxide in southeast Sarnia.
14061	Colborne and Fane St., Corunna	Sulphation Rate	4 m.	Monitors relative amount of sulphur oxide in a residential area of Corunna.

TABLE II - DESIRABLE AMBIENT AIR QUALITY CRITERIA  
ESTABLISHED FOR ONTARIO

PARAMETER	DESIRABLE AMBIENT AIR QUALITY CRITERIA	PRIME REASONS FOR ESTABLISHING CRITERIA OR MONITORING PARAMETER
Carbon Monoxide	30 ppm averaged for 1 hour	Protection of human health
	13 ppm averaged for 8 hours	Protection of human health
Dustfall	20 tons/mile <sup>2</sup> in 30 days	Historical and in keeping with other control agencies.
	13 tons/mile <sup>2</sup> (monthly average in 1 year)	
Fluoridation Rate	40 ug F/100 cm <sup>2</sup> of limed filter paper in 30 days during April 15 to October 15	Protection of vegetation
	80 ug F/100 cm <sup>2</sup> of limed filter paper in 30 days during October 16 to April 14	Protection of vegetation (less restrictive criterion during the non growing season).
Hydrocarbons (Total)	NONE	Effects of hydrocarbons vary widely depending on their chemical-physical nature.
Hydrocarbons (Reactive)	NONE	Reflects hydrocarbons most apt to react to form ozone, many of which are abundantly produced by man.

TABLE II - continued

PARAMETER	DESIRABLE AMBIENT AIR QUALITY CRITERIA	PRIME REASONS FOR ESTABLISHING CRITERIA OR MONITORING PARAMETER
Hydrocarbons (Non Reactive)	NONE	
Hydrogen Sulphide	0.02 ppm averaged for 1 hour	Protection against offensive odours.
Nitric Oxide	NONE	Reacts with oxygen to produce NO <sub>2</sub> .
Nitrogen Dioxide	0.02 ppm averaged for 1 hour	Protection of human health and protection against malodours.
	0.10 ppm averaged for 24 hours	Protection of human health and protection against malodours.
Nitrogen Oxides	NONE	
Ozone	0.08 ppm averaged for 1 hour	Protection of vegetation, adverse health effects.
Soiling (Coefficient of Haze - COH)	1.0 COH per 1000 ft. of air averaged for 24 hours	Based on health effects in combination with SO <sub>2</sub> .
	0.5 COH per 1000 ft. of air averaged for 1 year	Based on health effects in combination with SO <sub>2</sub> .

TABLE II - continued

PARAMETER	DESIRABLE AMBIENT AIR QUALITY CRITERIA	PRIME REASONS FOR ESTABLISHING CRITERIA OR MONITORING PARAMETER
Sulphation	0.7 mg of $\text{SO}_3$ per 100 $\text{cm}^2$ of lead peroxide per day based on 30 days of exposure	Serves to measure relative amounts of sulphur oxides over extended periods of time thus permitting comparisons to annual average $\text{SO}_2$ concentrations.
Sulphur Dioxide	0.25 ppm averaged for 1 hour	Protection of vegetation.
	0.10 ppm averaged for 1 day (24 hours)	Protection of human health.
	0.02 ppm averaged for 1 year	Protection of vegetation.
Suspended Particulates	120 $\text{ug}/\text{m}^3$ averaged for 24 hours	Based on impairment of visibility.
	A geometric mean of 60 $\text{ug}/\text{m}^3$ during 1 year.	Based on public awareness of visible pollution.

APPENDIX II

METEOROLOGICAL DATA



TABLE III - AVERAGE FREQUENCY OF WIND DIRECTION  
AT THE 62-METRE LEVEL OF STATION 14016

YEAR	PERCENT FREQUENCY OF WIND DIRECTION							
	N	NE	E	SE	S	SW	W	NW
1976	12.2	9.2	3.5	4.7	18.1	20.5	15.1	16.7
1975	11.5	11.2	7.3	7.5	18.6	18.3	11.7	13.8
1974	10.4	13.1	12.3	6.6	5.1	14.5	23.7	14.4
1973	12.4	12.4	10.5	7.9	7.4	15.0	21.4	13.0
1972	15.8	12.0	6.5	8.3	17.4	16.4	11.7	12.0

APPENDIX III

PARTICULATES

TABLE IV - CONCENTRATIONS OF DUSTFALL  
(TONS/SQUARE MILE) IN DOWNTOWN SARNIA

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	ANNUAL ARITHMETIC MEAN
STATION 14049													
1972	*	<u>21</u>	<u>22</u>	20	6	*	7	9	6	12	*	9	12
1973	15	10	<u>30</u>	13	<u>22</u>	13	11	8	10	17	<u>25</u>	10	<u>15</u>
1974	10	13	<u>28</u>	16	16	17	12	7	9	10	12	11	13
1975	12	12	17	17	17	13	9	19	12	16	11	8	<u>14</u>
1976	8	17	<u>23</u>	19	16	14	14	9	10	13	12	12	<u>14</u>
STATION 14051													
1972	*	*	*	<u>21</u>	*	*	6	19	14	11	*	9	13
1973	10	7	18	16	18	18	5	7	8	14	16	8	12
1974	<u>9</u>	14	20	20	16	20	14	8	12	13	9	12	<u>14</u>
1975	13	6	12	6	16	15	12	<u>26</u>	10	16	12	6	13
1976	9	14	19	15	14	13	10	9	8	9	8	8	11

UNDERLINED VALUES EXCEED EITHER THE CRITERION OF 20 TONS/mi<sup>2</sup>/30 DAYS OR THE ANNUAL CRITERION OF AN AVERAGE OF 13 TONS/mi<sup>2</sup>/30 DAYS.

TABLE V - TREND IN LEVELS OF SUSPENDED PARTICULATES  
1972 TO 1976

STATION NUMBER	1976		1975		1974		1973		1972	
	ANNUAL GEOMETRIC MEAN ug/m <sup>3</sup>	PERCENTAGE OF VALUES GREATER THAN 24 - HOUR CRITERION	ANNUAL GEOMETRIC MEAN ug/m <sup>3</sup>	PERCENTAGE OF VALUES GREATER THAN 24 - HOUR CRITERION	ANNUAL GEOMETRIC MEAN ug/m <sup>3</sup>	PERCENTAGE OF VALUES GREATER THAN 24 - HOUR CRITERION	ANNUAL GEOMETRIC MEAN ug/m <sup>3</sup>	PERCENTAGE OF VALUES GREATER THAN 24 - HOUR CRITERION	ANNUAL GEOMETRIC MEAN ug/m <sup>3</sup>	PERCENTAGE OF VALUES GREATER THAN 24 - HOUR CRITERION
14001	59	10	55	4	54	4	68	19	79	16
14016	48	2	48	2	50	5	61	17	67	10
14049	73	20	71	12	82	23	101	42	103	36
14051	57	9	61	9	80	23	91	36	88	33
14053	RELOCATED AT NEARBY 14057		52	8	55	14	61	17	71	15
14054	56	12	60	13	74	21	82	29	113	40
14057	59	13								
14059	40	0								
14061	RELOCATED AT NEARBY 14059		59	8	56	5	78	19	75	24
AVERAGE FOR ALL STATIONS	56	9	58	8	64	14	77	26	85	25

APPENDIX IV

CARBON MONOXIDE, TOTAL HYDROCARBONS,  
HYDROGEN SULPHIDE AND MERCAPTANS, OXIDES OF  
NITROGEN, TOTAL OXIDANTS, OZONE AND SOILING  
INDEX DATA OBTAINED AT STATION 14049  
IN DOWNTOWN SARNIA

TABLE VI - SUMMARY OF DATA FOR SOME POLLUTANTS MEASURED AT  
STATION 14049 IN DOWNTOWN SARNIA

	DATA SUMMARY BY YEAR	CARBON MONOXIDE	TOTAL HYDROCARBONS	HYDROGEN SULPHIDE & MERCAPTANS	NITRIC OXIDE	NITROGEN DIOXIDES	NITROGEN OXIDES	TOTAL OXIDANTS	OZONE	SOILING INDEX
1976	Annual Average (ppm)	1.3	2.3	0.001	0.02	0.03	0.05	NO	0.019	0.3*
	Percentage of Values Above The Criterion Established For:							DATA		
	1-Hour	---	---	0.04	---	0	---		0.7	---
	8-Hours	0	---	---	---	---	---		---	---
	24-Hours	0	---	---	---	0	---		---	0.6
1975	Annual Average (ppm)	0.9	2.6	0.001	NO	0.02	0.05	NO	0.024	0.3
	Percentage of Values Above The Criterion Established For:				DATA			DATA		
	1-Hour	---	---	0.38		0	---		1.9	---
	8-Hours	0	---	---		---	---		---	---
	24-Hours	0	---	---		0	---		---	0
1974	Annual Average (ppm)	1.0	2.8	0.007	NO	0.02	INSUFFI- CIENT	NO	0.018	0.3
	Percentage of Values Above The Criterion Established For:				DATA			DATA		
	1-Hour	---	---	9.78		0	DATA		1.1	---
	8-Hours	0	---	---		---			---	---
	24-Hours	0	---	---		0			---	0.3
1973	Annual Average (ppm)	NO	2.3	NO	NO	0.03	NO	0.03	NO	0.3
	Percentage of Values Above The Criterion Established For:	DATA		DATA	DATA		DATA		DATA	
	1-Hour		---			0		0.7		---
	8-Hours		---			---		---		---
	24-Hours		---			0		---		0

\* SOILING INDEX EXPRESSED AS COH/1000 FEET OF AIR

TABLE VI - continued

DATA SUMMARY BY YEAR		CARBON MONOXIDE	TOTAL HYDROCARBONS	HYDROGEN SULPHIDE & MERCAPTANS	NITRIC OXIDE	NITROGEN DIOXIDES	NITROGEN OXIDES	TOTAL OXIDANTS	OZONE	SOILING INDEX
1972	Annual Average (ppm)	2.6	2.3	NO	NO	0.03	NO	0.03	NO	0.4
	Percentage of Values Above The Criterion Established For:			DATA	DATA		DATA		DATA	
	1-Hour	---	---			0		0.9		---
	8-Hours	0	---			---		---		---
	24-Hours	0	---			0		---		0

## APPENDIX V

### SULPHUR OXIDES



TABLE VII - TREND IN LEVELS OF SULPHUR DIOXIDE  
1972 TO 1976

YEAR	STATION NUMBER 14004			STATION NUMBER 14016			STATION NUMBER 14049		
	ANNUAL AVERAGE (ppm)	PERCENTAGE OF VALUES GREATER THAN 1-HOUR CRITERION	PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION	ANNUAL AVERAGE (ppm)	PERCENTAGE OF VALUES GREATER THAN 1-HOUR CRITERION	PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION	ANNUAL AVERAGE (ppm)	PERCENTAGE OF VALUES GREATER THAN 1-HOUR CRITERION	PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION
1976	0.01	0.58	1.3	0.02	0.06	0.0	0.02	0.07	0.9
1975	0.01	0.36	0.7	0.02	0.07	0.0	0.02	0.07	0.9
1974	N O D A T A			0.02	0.14	0.0	0.03	0.44	1.2
1973	I N S U F F I C I E N T D A T A			0.01	0.05	0.0	0.02	0.17	0.3
1972	N O D A T A			I N S U F F I C I E N T D A T A			0.02	0.37	2.1

TABLE VIII - TREND IN LEVELS OF SULPHATION RATE  
1972 TO 1976

STATION NUMBER	1976		1975		1974		1973		1972	
	ANNUAL* AVERAGE	PERCENTAGE OF VALUES GREATER THAN MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES GREATER THAN MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES GREATER THAN MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES GREATER THAN MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES GREATER THAN MONTHLY CRITERION
14016	0.45	8	0.57	25	0.67	27	0.60	25	0.86	67
14049	0.76	33	0.81	58	0.96	82	0.94	75	1.02	83
14051	0.93	58	0.91	75	1.26	91	1.04	92	1.11	75
14053	0.32	0	0.34	0	0.47	9	0.42	0	0.47	8
14054	0.59	42	0.54	17	0.69	60	0.60	25	0.66	18
14055	1.07	75	0.98	75	0.97	60	1.05	100	1.21	92
14057	0.33	0	N O D A T A							
14058	0.48	18	0.61	29	0.71	45	0.62	42	0.69	33
14059	0.44	0	N O D A T A							
14060	0.50	25	0.56	17	0.67	45	0.69	50	0.70	33
14061	0.53	25	0.60	25	0.67	40	0.70	50	0.87	83

\* ANNUAL AVERAGE IS THE AVERAGE OF THE MONTHLY SULPHATION RATES EXPRESSED AS mg OF SO<sub>3</sub>/100 cm<sup>2</sup> OF FILTER/30 DAYS.

TABLE IX - SUMMARY OF SULPHATE CONTENT IN  
SUSPENDED PARTICULATES DURING 1976

STATION NUMBER	ANNUAL AVERAGE CONCENTRATIONS OF PARTICULATE SULPHATE AS SO <sub>3</sub> (ug/m <sup>3</sup> )	AVERAGE PERCENTAGE OF SULPHATE IN SUSPENDED PARTICULATES
14001	8.6	13
14016	8.4	16
14051	9.0	14
14054	9.6	14

APPENDIX VI

FLUORIDATION RATE

TABLE X - FLUORIDATION RATES  
(ugF/100 cm<sup>2</sup>/30 DAYS)  
FROM 1972 TO 1976

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	ANNUAL AVERAGE
STATION 14049													
1972	<u>85</u>	60	22	32	28	<u>56</u>	29	<u>80</u>	20	23	17	45	41
1973	55	50	60	<u>65</u>	<u>65</u>	<u>100</u>	<u>75</u>	<u>60</u>	40	<u>70</u>	55	55	63
1974	67	56	44	<u>66</u>	18	ND	<u>48</u>	ND	<u>50</u>	44	66	80	54
1975	31	39	19	18	ND	29	34	34	22	<u>74</u>	44	31	34
1976	37	53	36	11	18	24	6	<u>42</u>	32	27	29	31	29
STATION 14004													
1976	ND	ND	ND	ND	ND	<u>46</u>	38	<u>74</u>	<u>48</u>	39	21	40	44

NOTE: 1) ND - NO DATA  
2) UNDERLINED VALUES EXCEED DESIRABLE AMBIENT AIR CRITERIA

ONTARIO



\*96936000008011\*

1. THE STATE. NORTH AMERICA

DATE	ISSUED TO
	<i>P. Sinwelga</i>



— CAT. No. 23-115

PRINTED IN U. S. A.